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ABSTRACT

An analysis of scatter among the Tests of Cognitive Ability for the Woodcock-Johnson Psycho-Educational Battery was conducted on scores of 3,566 grade 1 through 12 students from the standardization sample. Large mean high subtest-low subtest differences were noted for each grade level and compared to Wechsler Intelligence Scale for Children-Revised scaled score ranges. Frequency distributions for high-low differences are presented as well as the mean differences between all pairwise combinations for the 12 subtests. The practice of examining scatter on the Tests of Cognitive Ability is discouraged. (Author)

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Research Report No. 46

AN ANALYSIS OF SUBTEST SCATTER ON THE TESTS OF COGNITIVE ABILITY FROM THE WOODCOCK-JOHNSON PSYCHO-EDUCATIONAL BATTERY

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Abstract

An analysis of scatter among the Tests of Cognitive Ability for the Woodcock-Johnson Psycho-Educational Battery was conducted on scores of subjects in grades 1 through 12 from the standardization sample. Large mean high subtest-low subtest differences were noted for each grade level and compared to WISC-R scaled score ranges. Frequency distributions for high-low differences are presented as well as the mean differences between all pair-wise combinations for the 12 subtests. The practice of examining scatter on the Tests of Cognitive Ability is discouraged.

An Analysis of Subtest Scatter on the Tests of Cognitive Ability from the Woodcock-Johnson Psycho-Educational Battery

The interpretation of subtest scatter on intelligence measures as indicative of learning disability has become common practice and is encouraged in major texts (Clements, 1966; Matarazzo, 1972; Sattler, 1974). Large discrepancies among subtest scores are said to be characteristic of children who are considered learning disabled.

Kaufman (1976), however, investigated the degree to which subtest scatter was prevalent in a large normal population. His analysis of the Wechsler Intelligence Scale for Children - Revised (WISC-R) standardization sample demonstrated that large inter-test variability was common among children considered normal. Specifically, Kaufman noted that the average child in the standardization sample obtained scores on the WISC-R subtests that ranged from 6-7 to 13-14. He stated, "it is typical for a normal child to demonstrate quite a bit of scatter in his [her] WISC-R profile" (p. 35). In addition, Kaufman demonstrated that a large proportion of the standardization sample exhibited significant differences between each pair of WISC-R scaled scores. Percentages ranged from 29% to 52%, with a mean of 44%. Kaufman concluded, "when a clinician observes numerous significant differences between pairs of test scores in a child's WISC-R protocol, it is important for him [her] to keep in mind that it is common for such differences to occur" (p.37).

Because such research findings are specific to the WISC-R and because of the widespread use of subtest scatter interpretation among psychologists, it is imperative that the scatter on other frequently used measures be examined. The purpose of this study was to analyze the

extent to which subtest scatter occurs in the Tests of Cognitive Ability from the Woodcock-Johnson Psycho-Educational Battery (Woodcock & Johnson, 1977). Although the test's authors do not recommend such a practice, it may be noted that the Summary of Scores section in the Response Booklet of the Tests of Cognitive Ability includes a subtest profile. This fact, combined with the recent publication of the subtest norms (Marston & Ysseldyke, 1980), may encourage psychologists to interpret subtest scatter. This paper seeks to clarify a number of issues in analysis of subtest scores by examining scatter in the W-J standardization sample.

Procedures

The subtest scores of 3566 grade 1-12 students from the standardization sample were examined. The reader is referred to Woodcock's (1978) technical manual for a detailed description of the norming sample. The specific subtests analyzed were Picture Vocabulary, Spatial Relations, Memory for Sentences, Visual-Auditory Learning, Blending, Quantitative Concepts, Visual Matching, Antonyms-Synonyms, Analysis-Synthesis, Numbers Reversed, Concept Formation, and Analogies. Woodcock's W-score, which is a logarithmic transformation based on a Rasch analysis of test items, was the unit of analysis.

Three indices of test scatter were computed for each of the 3566 children in the standardization sample. The first index of scatter was the difference between a child's highest subtest W-score and lowest subtest W-score. The means and standard deviations for these W-score differences were then calculated for the total sample, by grade level, by sex, and by race. In addition, the frequency distributions of the high-low differences were determined for the entire standardization sample

and by grade level.

The second index of test scatter was the direct transformation of the high-low W-score differences into high-low scaled score differences in which each Woodcock-Johnson subtest had a mean of 10 and a standard deviation of 3. The purpose of this transformation was to allow a comparison of subtest scatter on the W-J with Kaufman's (1976) scatter analysis of the WISC-R standardization sample. Means and standard deviations for these transformed scores were calculated for each grade level.

Analysis of the pair-wise subtest W-score differences for each individual in the norming sample produced the third and final index of subtest scatter. Means and standard deviations were computed for each posible subtest combination.

Results

The mean high-low subtest W-score differences and standard deviations for the total sample, for each grade level, for sex, and for race are presented in Table 1. For the entire standardization sample the average high-low W-score difference was 52.9 with a standard deviation of 18.0. One may expect then, that the scores of the middle 2/3 of the normal population will range from 35 to 71 when the high-low W-score subtest difference is calculated. Similar mean differences were found for each grade level, with mean high-low differences ranging from 41.6 (SD = 15.0) for grade 4 to 68.1 (SD = 19.7) for grade 11.

Insert Table 1 about here

Similar mean high-low differences were found for sex and race. Males averaged 53.1 and females 52.8. Whites averaged 52.4 and non-whites had a mean W-score difference of 56.8.

High-low W-score differences for each grade level also were transformed into scaled scores in which each subtest had a mean of 10 and a standard deviation of 3. The purpose of the transformation was to provide an opportunity for comparison of subtest scatter on the W-J with Kaufman's analysis of the WISC-R standardization sample. These data also are presented in Table 1. The mean high-low scaled score differences for each grade level ranged from 7.9 to 8.6, with standard deviations ranging from 2.2 to 2.7. These differences for the W-J standardization sample are remarkably similar to those for the WISC-R standardization sample. As Kaufman noted,

> the scaled-score range of 7 $\pm$ 2 for the regular full scale seems to be virtually a built-in constant, as the means and SDs for boys and girls, blacks and whites, young children and adolescents, children from high and low SES backgrounds, and children having a wide range of IQs, all hovered closely around the values of 7 and 2, respectively. (Kaufman, 1976, p. 35)

Table 2 is a list of the cumulative percentage of the norming population with corresponding high-low subtest differences for the entire sample, grades 1-6, grades 7-12, and for each grade level. It would appear that a significant proportion of the standardization sample demonstrates a large degree of subtest scatter. Fifty percent of the entire sample had at least a high-low difference of 50, 30% had at least a W-score difference of 60, and about 14% of the subjects had a W-score scatter of at least 70 points.

Insert Table 2 about here

Mean W-score differences and standard deviations for all pair-wise subtest combinations from the standardization sample are provided in Table 3. For the 66 possible combinations, mean differences ranged from 11.1 (SD = 9.3) for Antonyms and Analogies to 28.9 (SD = 20.9) for Visual Matching and Visual-Auditory Learning. The average pair-wise difference for the Tests of Cognitive Ability was 18.0 points.

Insert Table 3 about here

Discussion

The findings of this study of scatter on the W-J subtests in many ways replicate Kaufman's findings for the WISC-R. These similarities include: (a) significant proportions of the standardization sample exhibit large high-low subtest differences; (b) mean high-low subtest differences are fairly constant across grade level, sex, and race; and (c) standard deviations of the subtest differences are quite stable. Because W-score units may be less familiar to practicing psychologists, the large mean subtest differences in the normal sample are not easily interpreted. The transformation to scaled scores with a mean of 10 and standard deviation of 3 provides familiar numbers for judging the degree of subtest scatter in the W-J Tests of Cognitive Ability. These data confirm that the mean high-low subtest differences on the W-J are similar to Kaufman's WISC-R scaled score range. Such findings indicate that the practice of using W-J subtest scatter to diagnose learning disabled children should be discouraged for the same reasons that Kaufman has cautioned practitioners about use of scatter analysis with the WISC-R.

This position has been verified in a comparison of W-J subtest scatter in LD and non-LD groups. Ysseldyke, Shinn, McGue, and Epps (1980) provided evidence that there is little difference in the variability of subtest scores of learning disabled elementary students and peers who are considered low achievers. How, then, can the practitioner make a differential diagnosis based on W-J scatter?

Because of the expected scatter in normal W-J protocols, there seems to be little reason to practice scatter analysis with the Tests of Cognitive Ablility. Until contrary evidence is presented, the burden of proof remains with those who would perpetuate a practice that encourages invalid diagnosis of learning disabilities.

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Table 1

Mean W-Score and Scaled Score Differences and Standard Deviations for Highest and Lowest Cognitive Subtests from the Standardization Sample

Group Grade	N	Mean W-Score	SD	Mean Scaled Score	SD
1	512	61.3	15.9	8.5	2.6
2	285	50.1	15.7	8.1	2.7
3	468	44.8	14.7	8.3	2.5
4	177	41.6	15.0	7.9	2.5
5	592	43.2	13.7	8.3	2.4
6	158	45.4	14.4	8.1	2.2
7	155	50.9	16.8	8.5	2.5
8	472	54.8	15.8	8.5	2.4
9	126	58.2	15.3	8.5	2.2
10	119	63.6	18.9	8.6	2.7
11	113	68.1	19.7	8.5	2.6
12	389	65.6	19.0	8.5	2.6
Grades 1-6	2192	48.7	16.6		
Grades 7-12	1374	59.6	18.4		
Grades 1-12	3566	52.9	18.0		
Sex					
Male	1652	53.1	17.7		
Female	1914	52.8	18.5		
Race					
White	3138	52.4	17.7		
Minority	428	56.8	20.1		

Table 2

Cumulative Percentage by Grade Level for W-Score Range for Lowest and Highest Cognitive Subtest in Standardization Sample

	Range in W-Score Subtest Scatter																					
	0 5	6 10	11 15	16 20	21 25	26 30	31 35	36 40	41 45	46 50	51 55	56 60	61 65	66 70	71 75	76 80	81 85	86 90	91 95	96 100	100 105	105 110	110 115
Grade																							
1						1.0	2.0	5.7	11.7	24.8	39.3	56.4	69.5	77.9	83.0	87.9	90.8	93.8	96.1	97.5	98.6		
2					1.4	6.0	14.4	27.4	42.5	58.6	70.0	78.2	86.3	92.3	94.3	95.9	96.3	97.3	97.9	98.4			
3			.2	1.1	4.7	14.5	29.5	45.3	57.7	69.9	78.0	86.8	91.5	95.3	97.4	98.5	98.9	99.0	99.4	99.5			
4				1.7	7.3	20.3	41.2	54.2	68.4	79.1	86.4	92.1	94.7	96.6	97.4	98.5	.						
5			.2	2.0	6.4	16.7	30.7	47.3	63.5	75.5	82.8	88.3	92.9	96.0	97.6	98.5	99.0						
6					4.4	12.7	25.3	41.6	56.3	70.9	82.3	86.3	91.1	93.5	96.3	97.0	98.1	99.0					
7				.9	1.9	7.5	17.4	29.7	41.9	52.3	63.9	75.5	85.8	90.3	92.9	95.2	95.8	97.4	98.7				
8				.3	1.1	3.8	8.7	18.4	30.5	42.6	54.7	66.9	77.3	86.4	91.3	93.9	95.2	96.2	98.0	98.9			
9						.7	3.2	13.5	20.6	29.4	45.2	59.5	71.4	82.5	89.7	94.4	96.8	98.6					
10						1.7	4.1	7.9	16.0	23.5	32.8	46.2	61.3	74.8	80.7	86.2	87.8	90.5	93.6	95.4	96.5	97.2	97.5
11						1.4	3.0	6.2	9.4	16.8	26.5	38.1	49.6	66.4	73.5	77.9	79.9	81.4	89.4	92.4	94.7	97.5	
12							1.3	6.9	12.3	21.3	30.6	43.2	56.6	68.1	74.3	82.5	86.1	89.2	93.1	95.9	96.7	97.6	98.0
1-6			.1	.9	3.8	11.2	22.1	34.7	47.3	60.2	70.3	79.4	86.3	91.0	93.6	95.5	96.6	97.6	98.4	98.9			
7-12				.1	.6	2.3	5.9	14.0	22.7	32.7	43.8	56.3	68.2	78.7	84.1	88.8	90.8	92.6	95.5	97.1			
1-12			.1	.6	2.6	7.7	15.8	26.7	37.8	49.6	60.1	70.5	79.3	86.2	89.9	92.9	94.4	95.7	97.3	98.2			

Table 3

Mean W-Score Differences and Standard Deviations for all Pair-Wise Cognitive Subtest Combinations from the Standardization Sample (Grades 1-12)

		PV	SR	MS	VA	B	QC	VM	ANT	AN-SY	NR	CF
Picture Vocabulary (PV)	$\bar{X}$											
	SD											
Spatial Relations (SR)	$\bar{X}$	14.9										
	SD	11.3										
Memory for Sentences (MS)	$\bar{X}$	15.7	16.3									
	SD	12.1	12.6									
Visual-Auditory Learning (VA)	$\bar{X}$	17.4	11.6	16.4								
	SD	12.5	8.9	12.6								
Blending (B)	$\bar{X}$	18.0	15.1	17.4	13.6							
	SD	13.8	11.6	13.6	10.8							
Quantitative Concepts (QC)	$\bar{X}$	17.4	22.8	22.4	27.9	27.0						
	SD	13.0	16.2	16.7	18.1	18.7						
Visual Matching (VM)	$\bar{X}$	21.9	23.5	25.4	28.9	28.6	16.9					
	SD	17.4	18.4	19.6	20.9	21.6	14.2					
Antonyms-Synonyms (ANT)	$\bar{X}$	11.2	16.2	16.2	19.6	19.4	14.4	19.3				
	SD	9.1	12.5	12.6	14.2	14.4	11.0	15.7				
Analysis-Synthesis (AN-SY)	$\bar{X}$	15.2	12.1	16.2	11.7	15.5	23.0	24.5	16.1			
	SD	11.6	9.3	12.7	9.4	12.0	15.6	19.1	12.1			
Numbers Reversed	$\bar{X}$	19.0	17.3	18.7	18.8	20.2	22.0	23.0	18.4	17.4		
	SD	15.2	15.3	15.0	16.5	16.5	16.1	17.9	14.5	15.0		
Concept Formation	$\bar{X}$	16.2	14.7	17.0	15.5	17.6	22.2	24.4	15.8	13.3	19.0	
	SD	12.7	11.6	13.3	12.6	14.1	16.0	19.0	12.0	11.0	15.1	
Analogies (A)	$\bar{X}$	12.0	13.4	14.9	15.3	16.9	17.7	21.5	11.1	13.2	17.0	13.7
	SD	9.4	10.5	11.6	11.4	13.1	13.0	16.8	9.3	10.3	14.5	10.8

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